(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 480 053 A1**

(12) **EUROPEAN PATENT APPLICATION published in accordance with Art. 158(3) EPC**

(21) Application number: **91906583.9**

(51) Int. Cl.5: **F16L 47/02**, B29C 65/36

(22) Date of filing: **29.03.91**

(86) International application number:
PCT/JP91/00412

(87) International publication number:
WO 91/15706 (17.10.91 91/24)

(30) Priority: **30.03.90 JP 86847/90**

(43) Date of publication of application:
15.04.92 Bulletin 92/16

(84) Designated Contracting States:
AT BE CH DE DK ES FR GB GR IT LI LU NL SE

(71) Applicant: **KUBOTA CORPORATION**
2-47, Shikitsuhigashi 1-chome, Naniwa-ku
Osaka-shi, Osaka 556-91(JP)
Applicant: **METCAL INC.**
1530 O'Brien Drive
Menio Park California 94025(US)

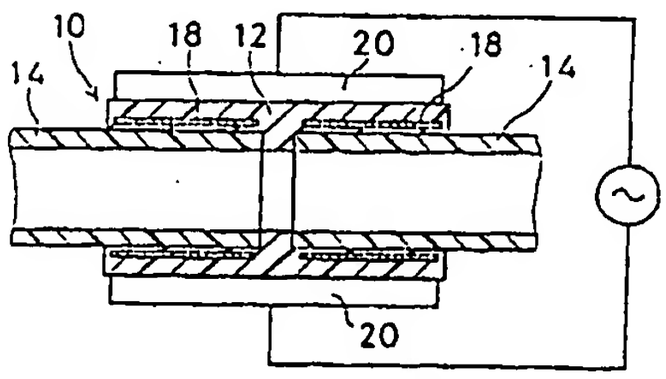
(72) Inventor: **GOTO, Yuichiro, Kubota Corporation**
Sakai P.V.C. Pipe Plant 64, Ishizu-Kitamachi
Sakai-shi Osaka 590(JP)
Inventor: **KASA, Hideki, Kubota Corporation**
Sakai P.V.C Pipe Piant 64, Ishizu-Kitamachi
Sakai-shi Osaka 590(JP)
Inventor: **HARADA, Takatomo, Kuboto Corporation**
Sakai P.V.C. Pipe Piant 64, Ishizu-Kitamachi
Sakai-shi Osaka 590(JP)

(74) Representative: **Hayward, Denis Edward Peter**
Lloyd Wise, Tregear & Co. Norman House
105-109 Strand
London WC2R 0AE(GB)

(54) **ELECTRICALLY FUSION-BONDED JOINT.**

(57) An electrically fusion-bonded joint includes a body proper and is provided with a heater including a magnetic alloy piece having a fixed degree of Curie temperature at a portion in the vicinity of the body proper surface to be bonded so that the surface of the heater is exposed outside from the body proper surface to be bonded. When the body proper surface to be bonded is brought into contact with the surface of a member to be bonded and high frequency current is supplied to the magnetic alloy piece by electric induction, the magnetic alloy piece generates heat and the temperature thereof is kept at a fixed degree of Curie temperature by temperature self-control function thereof. Accordingly, when a Curie temperature is set at a degree for fusion-bonding, the body proper surface and the member to be bonded are fusion-bonded.

FIG. 2



EP 0 480 053 A1

Field of Technology

This invention pertains to an electric fusion coupling. More specifically, it pertains to an electric fusion coupling which is utilized to connect synthetic resin pipes, etc.

Prior Art

An example of prior electric fusion couplings used to connect pipes made of polyethylene, polybutene and other synthetic resins is disclosed in the U.S. Patent No. 4, 117, 311 (September 26, 1978) and the U.S. Patent No. 4,486, 650 (December 4, 1984).

As indicated in Fig. 15, an electric fusion coupling 1 of the prior art includes the body 2 which is a hollow cylindrical pipe made of synthetic resin. Buried in the inner section of the body 2 is the electric heating wire 3, while both ends of the electric heating wire 3 are attached to the terminals 4 which project from the body 2.

In such an electric fusion coupling 1 of the prior art, there were problems in manufacturing since terminals 4 have to be shaped in both end sections of the electric heating wire 3.

Moreover, since the heating was accomplished by the electric heating wire 3, the temperature control was difficult, and there easily emerged a temperature unevenness, which constituted another problem.

Summary of Invention

Therefore, the main purpose of this invention is to offer a new electric fusion coupling.

Another purpose of this invention is to offer an electric fusion coupling which would be simple in manufacturing.

Another purpose of this invention is to offer an electric fusion coupling that does not generate temperature unevenness.

Still another purpose of this invention is to offer an electric fusion coupling which uses a magnetic alloy body as a heater.

An electric fusion coupling according to this invention connects members to be connected made from the 1st synthetic resin, and is equipped with the following: the main body which is made of the 2nd synthetic resin and has the 2nd joining surface which has practically the same curve as the 1st joining surface, while the above-mentioned 1st and 2nd synthetic resins have their respective 1st and 2nd melting temperatures; a heater which is located so as to expose at least a part of its surface on the 2nd joining surface and includes a magnetic alloy body, and the aforesaid magnetic alloy body has a high Curie temperature equal to or higher than the melting temperatures of the 1st and 2nd synthetic resins.

The heater is buried, e.g., in the vicinity of the 2nd joining surface of the body, and the surface of this heater is exposed on the 2nd joining surface. The Curie temperature of the magnetic alloy that makes up the heater is established as an optimal temperature slightly higher than the melting temperatures of the 1st and 2nd synthetic resins.

The 2nd joining surface of the body follows one of the joining surfaces of the heater joining member. In this situation, when a high frequency current is applied by magnetic induction to the magnetic alloy which makes up the heater, the magnetic layer is heated by the skin effect, the temperature of the magnetic alloy body and hence of the heater is increased. Thereupon, if the temperature of the heater reaches the Curie temperature, the magnetic permeability of the magnetic alloy body rapidly decreases, the current is almost entirely discontinued, and the temperature of the magnetic alloy body, i.e., the heater, no longer increases. If the temperature of the heater is reduced by heat conduction, then the magnetic permeability of the magnetic alloy body is increased, and an electric current again flows in the magnetic alloy body. Since such actions are recurrent, the temperature of the magnetic alloy body, i.e., the heater, is maintained actually at a constant level of Curie temperature. Consequently, the 1st and the 2nd joining surfaces are heated to the Curie temperature or to a value close to it, i.e., to the optimal temperature, the members to be connected and the 1st and the 2nd joining surfaces of the body as well as its surroundings are melted, and the member to be connected and the body are fused.

According to this invention, there is no need to shape welding terminals, as was the case in the prior art, exclusively by installing a heater in the body which includes a magnetic alloy body, therefore the structure of the electric fusion coupling is simplified, thus a fusion coupling can be manufactured in a simple manner. Moreover, the temperature of the heater can be controlled to be almost constant, using the Curie temperature of the magnetic alloy body, therefore it is possible to heat the entire 1st and 2nd joining surfaces constantly to a fixed temperature. If the surface of the magnetic alloy body and hence that of the heater is installed in the body in such a way as to be exposed on the 2nd joining surface, then this heater can heat directly not only the 2nd joining surface of the body, but also the 1st joining surface of the member to be connected. Therefore, the two of them can be melted and joined within a short time. Further, if the heater is buried in the body entirely without exposing itself on the surface, then the 2nd synthetic resin of the body is interposed between the

heater and the 1st joining surface of the member to be connected. Therefore the strength of coupling on both sides of the body which hold the heater between them was insufficient. If on the other hand, the heater whose surface is exposed on the 2nd joining surface, is buried in the body, the 2nd synthetic resin of the body is not interposed between the heater and the 1st joining surface of the member to be connected, and since the heater is held directly between the body and the member to be connected, a sufficiently large coupling strength can be attained.

In a preferable example of this invention, the magnetic alloy body which constitutes the heater is incorporated into the body in the shape of a plate (plate, wavy plate, etc.), punching metal, mesh, coil, ring or a thin film. Such magnetic alloy bodies can be constituted as a layer of synthetic resin with magnetic powder admixed to it. In this event, the synthetic resin of the synthetic resin layer can be the 2nd synthetic resin.

The above-mentioned purposes of this invention, as well as its other purposes, characteristic features, aspects and advantages will become clearer from the following detailed explanation of a practical example which is provided in conjunction with the attached Figures.

Brief Explanation of Figures

Fig. 1 is a cross-section which shows a practical example of this invention.

Fig. 2 is a cross-section which shows the situation of the coupling of the Practical Example in Fig. 1.

Figs. 3 - Fig. 11 are cross-sections which show different modified examples of heaters.

Fig. 12 is an oblique view which shows another practical example of this invention.

Fig. 13 A and 13 B serve to explain another practical example of this invention. Fig. 13 A is a cross-section, Fig. 13 B shows the bottom surface.

Fig. 14 is a cross-section which shows another practical example of this invention.

Fig. 15 is a cross-section which shows prior art.

The Best Ways to Implement the Invention

Referring to Fig. 1, the electric fusion coupling 10 of this Practical Example includes a hollow cylindrical body 10 made of polyethylene and other synthetic resins. The hollow inside of the body 12 acts as a socket 16 which accepts the pipe 14 mentioned below. Close to the inner surface of the socket 16, i.e., the joining surface (the 2nd joining surface) there is buried a cylindrical magnetic alloy body 18. The magnetic alloy body 18 acts as a heater, it has a fixed Curie temperature. Such a magnetic alloy body 18 can be the magnetic alloy body disclosed in the U.S. Patent No. 4, 256, 945 (March 17, 1981), therefore here we adopt it by quoting without resorting to a detailed explanation. The Curie temperature of the magnetic alloy body 18 can be adjusted by varying the composition ratio of the components which constitute the alloy. The Curie temperature is established at the optimal temperature of the coupling. Of course, this optimal temperature varies according to the particular kind of the 1st synthetic resin used in the pipe 14 to be connected and of the 2nd synthetic resin used in the body 12.

Referring to Fig. 2, the pipe 14 made of polyethylene, polybutene and other synthetic resins is inserted into sockets 16 on the right and left of the electric fusion coupling, and then a high frequency electric current is applied by electric inductance to the magnetic alloy body 18 buried inside the coupling 10 using a high frequency power source. Then, the magnetic alloy body 18 is heated rapidly, since due to the skin effect, the electric current is only concentrated in the skin section. When the temperature of the magnetic alloy body 18 is increased and reaches the Curie temperature, its magnetic permeability diminishes rapidly, so that the skin current is discontinued, thus the heating of the magnetic alloy body 18 becomes exceedingly small. When the heat of the magnetic alloy body 18 propagates to the body 12 and the pipe 14, reducing the temperature of the magnetic alloy body 18, the magnetic alloy body 18 is again heated by the skin current. Consequently, the magnetic alloy body 18, i.e., the heater, maintains an almost constant temperature which is the Curie temperature or close to it. Thus, the joining surfaces of the body 12 and pipe 14 as well as the synthetic resin in their vicinity are melted and the two become fused.

The high frequency power source that can be used can be, e.g., the high frequency power source disclosed in the U.S. Patent No. 4, 769, 519 (September 6, 1989). Therefore, here it is adopted by quoting, without resorting to a detailed explanation.

According to this practical example, a high frequency current is applied to the magnetic alloy body 18 by means of electromagnetic induction. Therefore the electric fusion coupling 10 can be manufactured easily without any need to shape welding terminals.

Heaters that can be used are not restricted to the practical example of Fig. 1, instead, they include e.g., those shown in Fig. 3 - 11.

In the practical example indicated in Fig. 3, the heater 11 is used which connects in series the left and right magnetic alloy bodies 18 in the Practical

Example of Fig. 1 by means of a connecting section 24. In order for the connecting section 24 to prevent the central part 22 of the body 12 from melting as efficiently as possible, it is shaped partly around the body 12. By connecting the two magnetic alloy bodies 18 by means of such a connecting section 24, it is ensured that the positions of both magnetic alloy bodies 18 are not dislocated along the diameter of the body 12, therefore the fusion is accomplished with more reliability.

The heater 13 shown in Fig. 4 includes the magnetic alloy body 28, cylindrical (or planar) in shape. On the external surface of (or internal surface) of the magnetic alloy body 28, there are a number of projecting lines 26 extending along the circumference. These projecting lines 26 have a double function, i.e., preventing separation between a magnetic alloy body 28 and the body 12, and expanding the heating area.

The heater 15 shown in Fig. 6 includes a cylindrical magnetic alloy body 30 shaped by a wave plate. The reason why this magnetic alloy body 30 is constituted by a wave plate is the same as in the Practical Example of Fig. 4.

In the Practical Example indicated in Fig. 6, the heater 17 is constituted by a magnetic alloy body 34 shaped as punching metal. I.e., there are a number of pieced holes 32 on the lateral surface of the magnetic alloy body 34. These pierced holes 32 are efficient to prevent separation between the magnetic alloy body 34 and the body 12. That is, since the synthetic resin of the body 12 involves the magnetic alloy body 34 via the pierced holes 32, separation between the two of them can be prevented.

If a sufficient aperture ratio is not obtained in the punching metal shown in Fig. 6, the heater 19 can also be used which is constituted by the mesh-shaped magnetic alloy body 36 indicated in Fig. 7. Thus the introduction of the synthetic resin of the body 12 is promoted via these apertures, while separation between the mesh magnetic alloy body 36 and the body itself can be further prevented.

Even using the heater 21 made of a coil-shaped magnetic alloy body 38 as indicated in Fig. 8, the same effect as in the Practical Example of Fig. 7 can be expected. The Practical Examples shown in Figs. 6 - 8 are advantageous in that they enable one to reduce the amount of magnetic alloy.

In Practical Examples indicated in Figs. 1 - 8, the electric fusion coupling 10 was obtained by ejection molding of the body so as to mold the magnetic alloy body inside the body. But the shape of the magnetic alloy body can be further modified as follows.

In the Practical Example indicated in Fig. 9, the heater 23, i.e., the magnetic alloy body, is shaped as the magnetic alloy layer. That is, in this Practical Example, a magnetic alloy layer is shaped close to the joining surface of the body 12, the magnetic alloy layer includes magnetic alloy powder that has a fixed Curie temperature admixed to the synthetic resin. In this way, if the magnetic alloy body is constituted by a magnetic alloy layer, then not only is it easier to manufacture the electric fusion coupling 10, but the problem of separation between the magnetic alloy body (layer) and the body 12 is solved.

The heater 25 shown in Fig. 10 includes a magnetic alloy thin film with which to coat the joining surface of the body 12. Thus if the heater 25 is constituted by a magnetic alloy thin film 42, then the surface of the heater 25 is exposed on the 2nd joining surface of the body 12. According to the Practical Example wherein the heater 25 is exposed on the 2nd joining surface, the heater 25 can heat directly not only the body 12, but also the members to be joined, i.e., the pipe 14 (Fig. 1), therefore the two joining surfaces can be fused within a short period of time. Moreover, since according to this practical example, the magnetic alloy body 42 is held on both sides directly by the body 12 and the pipe 14 (Fig. 1), the joining strength can be expected to further increase.

As in the Practical Example of Fig. 11, the magnetic alloy thin film 29 used as the heater 27, can be applied as a coating inside a groove shaped on the joining surface of the body 12.

It can be easily understood that the concept of exposing the heater, i.e., the magnetic alloy body (layer), on the joining surface of the body 12 can be applied in a similar manner to the individual Practical Examples shown in Fig. 1 and in Fig. 3 - 9.

This invention can be applied to the joining of a variety of pipe members: a socket 44 divided in two pieces as indicated in Fig. 12, a saddle 31 as indicated in Fig. 13 A and 13 B, or an elbow 33 as indicated in Fig. 14, and other tees, reducers, etc., not indicated in Figures.

The two-section socket 44 indicated in Fig. 12 consists of the top section 46 and bottom section 48. Magnetic alloy powder is kneaded into the sections close to their respective inner surfaces as indicated in the practical Example of Fig. 9. During the joining, the pipe 50 is held on both sides by the top and bottom pieces of the two-piece socket 44 in such a way as to bring the extremities of the 2 pipes 50 to be connected butt to butt and place the confronting sections 52 in vacuum. The top and bottom pieces are fixed by a clamp tool, and a high frequency current is applied to the magnetic alloy powder 40. In this way, the magnetic alloy powder 40 is heated similarly to previous Practical Examples and the top and bottom pieces of the

two-piece socket 44 become fused, while the pipe 50 can be connected at the same time.

If this two-piece socket 44 is used, the time required to insert the pipe 50 into the coupling socket is reduced, therefore the manufacturing efficiency can be increased, which is especially advantageous for large diameter pipes which are becoming increasingly important. In this practical example, too, any of the heaters of the Practical Examples of Fig. 1, Fig. 3 - 8, and Figs. 10 - 11 can be used.

The saddle 31 shown in Fig. 13 A and 13 B includes a seating section 35, on the inside surface of the seating section 35, i.e., in the vicinity of the joining surface, in a position indicated in Fig. 13 A and 13 B, or by a 2-dash line in Fig. 13 B, a heater 37 is shaped according to any of the previous Practical Examples. In the center of the seating section 35 there is shaped a branch pipe 39. In this Practical Example, too, the heater 37 can be heated by an induced high frequency current.

The elbow 33 shown in Fig. 14 includes a body 41, in the vicinity of the inner surface of the socket 43, there is shaped a heater 45 according to any of the previous examples. In this Practical Example, as well, the heater 45 can be heated by an induced high frequency current.

It is understandable of course, that in Practical Examples of Fig. 3, the Practical Examples of Fig. 13 A and 13 B, as well as in the Practical Example indicated in Fig. 14 C, the heater can be exposed on the joining surface of the body.

This invention has been explained in detail and shown in Figures. However, it is understandable that what has been used as simple graphic explanations and an example should not be understood as a restriction. The spirit and scope of this invention is restricted solely by the text of the attached claims.

Claims

1. An electric fusion coupling which connects members to be connected which are made of the 1st synthetic resin and have the 1st joining surface, is quipped with the following:

   a body which has the 2nd joining surface made of the 2nd synthetic resin and shaping actually the same curved surface as that of the aforesaid 1st joining surface of the above-mentioned members to be connected, the above-mentioned 1st and 2nd resins having the 1st and 2nd melting temperatures respectively; and also

   a heater installed on the aforesaid body at least a part of whose surface is exposed on the above-mentioned 2nd joining surface, which has a temperature self-adjustment function, and which includes a magnetic alloy body, the aforesaid magnetic alloy body having a high Curie temperature equal to or exceeding both the 1st and the 2nd melting temperature.

2. The electric fusion coupling according to Claim 1, with the aforesaid heater including a plate-shaped magnetic alloy body.

3. The electric fusion coupling according to Claim 1, with the aforesaid heater including punching metal made of a magnetic alloy.

4. The electric fusion coupling according to Claim 1, with the aforesaid heater including a mesh-type magnetic alloy body.

5. The electric fusion coupling according to Claim 1, with the aforesaid heater including a coil-shaped magnetic alloy body.

6. The electric fusion coupling according to Claim 1, with the aforesaid heater including a magnetic alloy thin film.

7. The electric fusion coupling according to Claim 1, with the aforesaid heater including synthetic resin layer with a magnetic alloy powder admixed to it.

8. The electric fusion coupling according to Claims 1 to 7, with the aforesaid body having at least 2 sockets, while the above-mentioned body is installed at every socket.

9. The electric fusion coupling according to Claim 8, with the aforesaid heaters further equipped with connecting sections to mutually connect them.

10. The electric fusion coupling according to any of the Claims 1 to 9, with the aforesaid body consisting of the 1st and 2nd body sections each of which has the aforesaid 2nd joining surface inside, and which have a semi-circular cylindrical shape, while the above-mentioned 1st and 2nd body sections cooperate and make up 1 socket.

11. The electric fusion coupling according to any of the claims 1 to 9, with the aforesaid body including a seating section with the aforesaid 2nd joining surface on its inside.

12. An electric coupling which connects members

to be connected that are made of the 1st synthetic resin and have the 1st joining surface, equipped with the following:

a body which has the 2nd joining surface made of the 2nd synthetic resin and contacting the aforesaid 1st joining surface, while the above-mentioned 1st and 2nd synthetic resins have the 1st and 2nd melting temperatures, respectively; and also

the magnetic alloy powder kneaded into the vicinity of the above-mentioned 2nd joining surface of the aforesaid body, said magnetic alloy powder having a high Curie temperature equal to or exceeding both the 1st and the 2nd melting temperatures.

SUMMARY

An electric fusion coupling which includes a body, with a heater that includes a magnetic alloy body with a prescribed Curie temperature close to the joining surface of the body installed so as to have its surface exposed on the joining surface. The joining surface of the body is allowed to contact the joining surface of the member to be connected, and when a high frequency electric current is applied to a magnetic alloy body by means of magnetic inductance, it is heated, while the temperature of the magnetic alloy body is kept at a prescribed Curie temperature level by means of its temperature self-adjustment function. Consequently, if the Curie temperature is set at the fusion temperature, the body is fused to the joining surface of the member to be connected.

FIG. 1

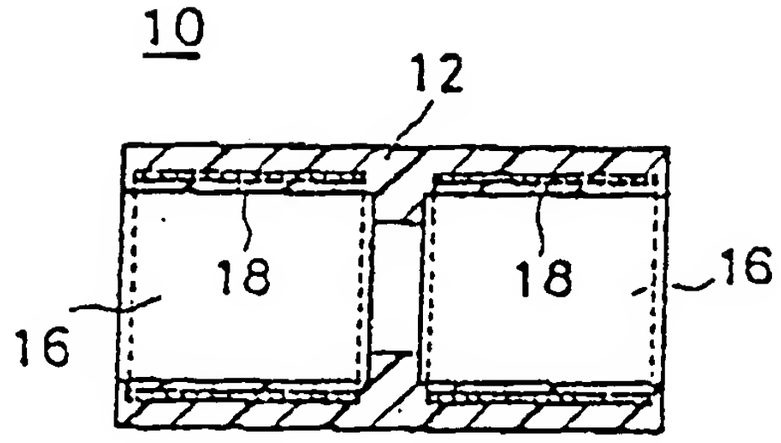


FIG. 2

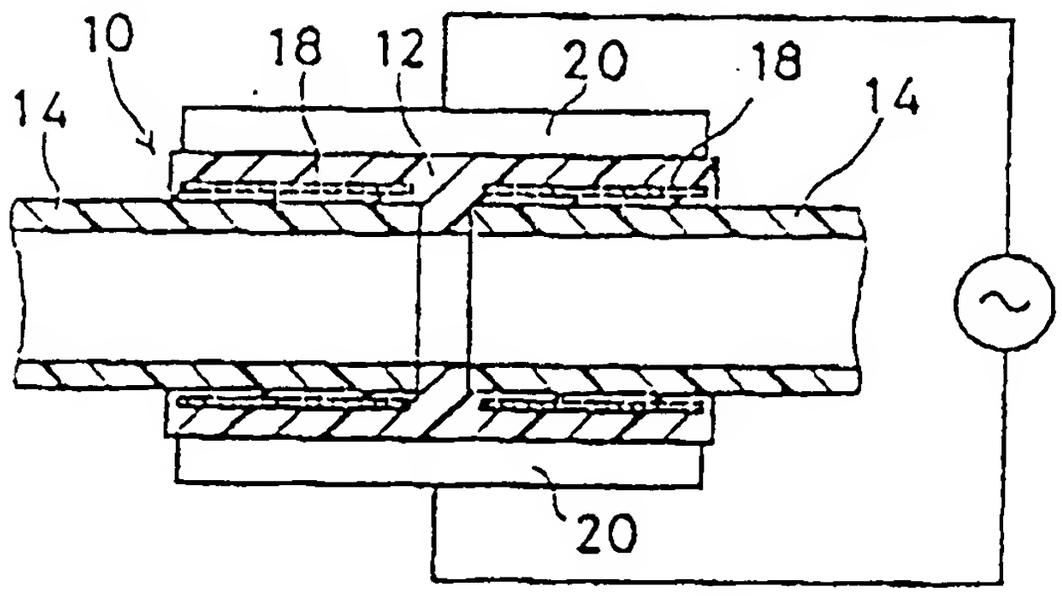


FIG. 3

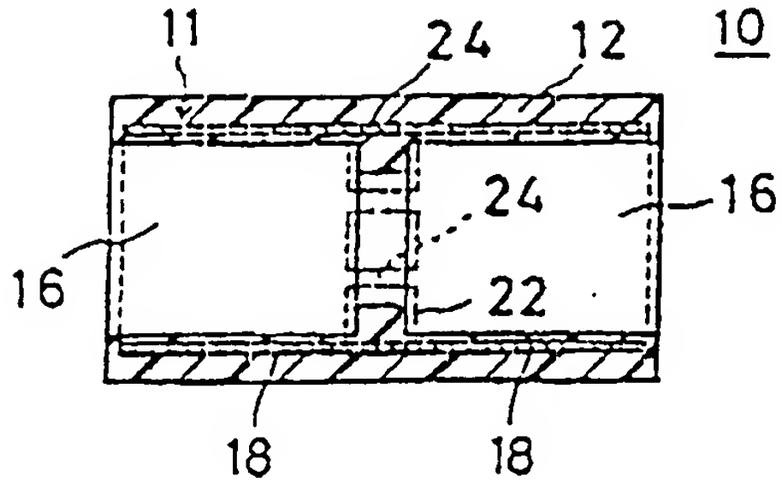


FIG. 4

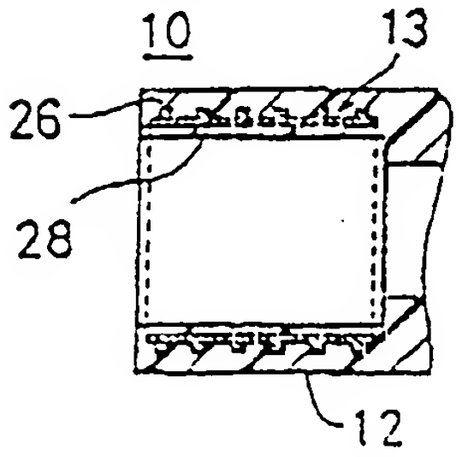


FIG. 5

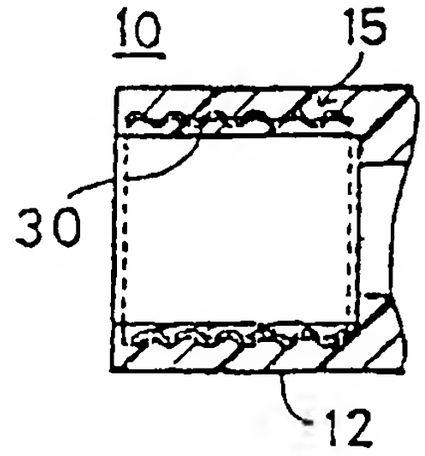


FIG. 6

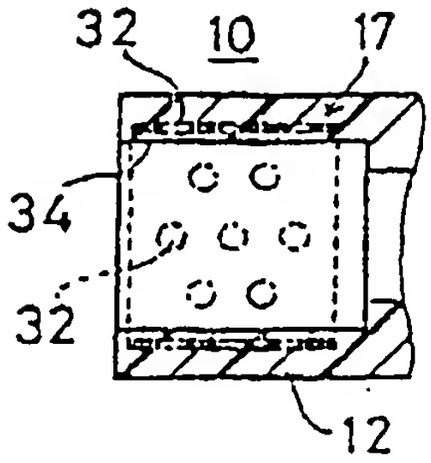


FIG. 7

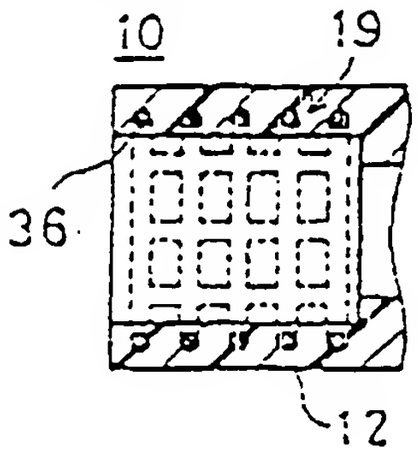


FIG. 8

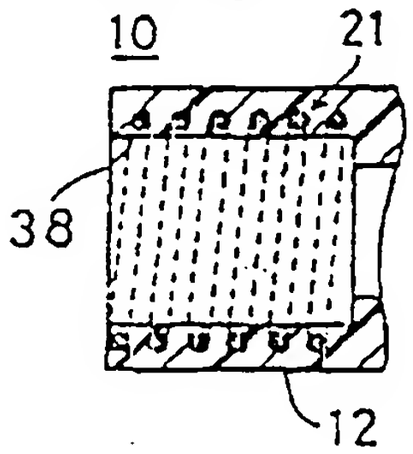


FIG. 9

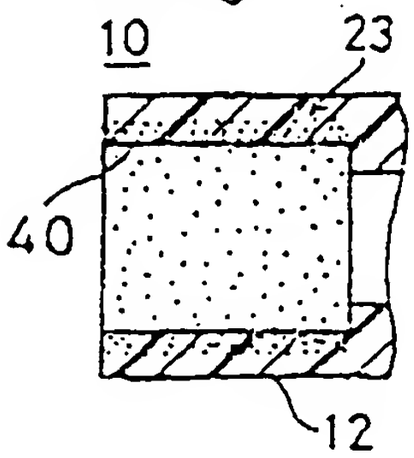


FIG. 10

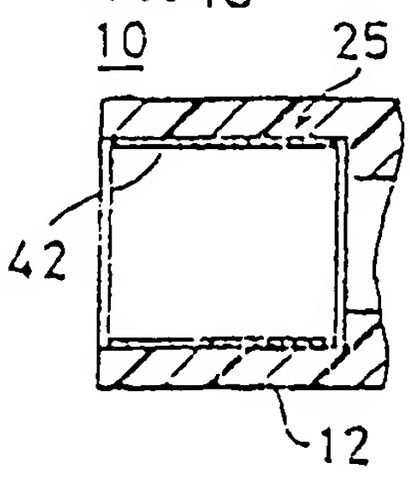


FIG. 11

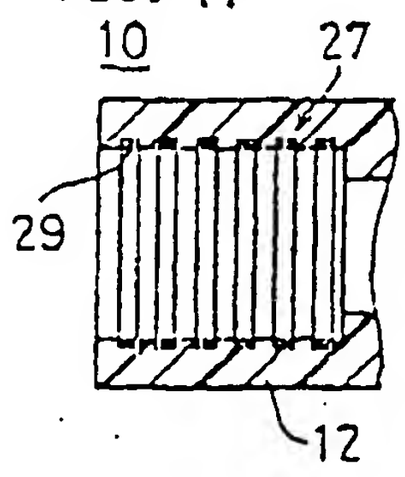


FIG. 12

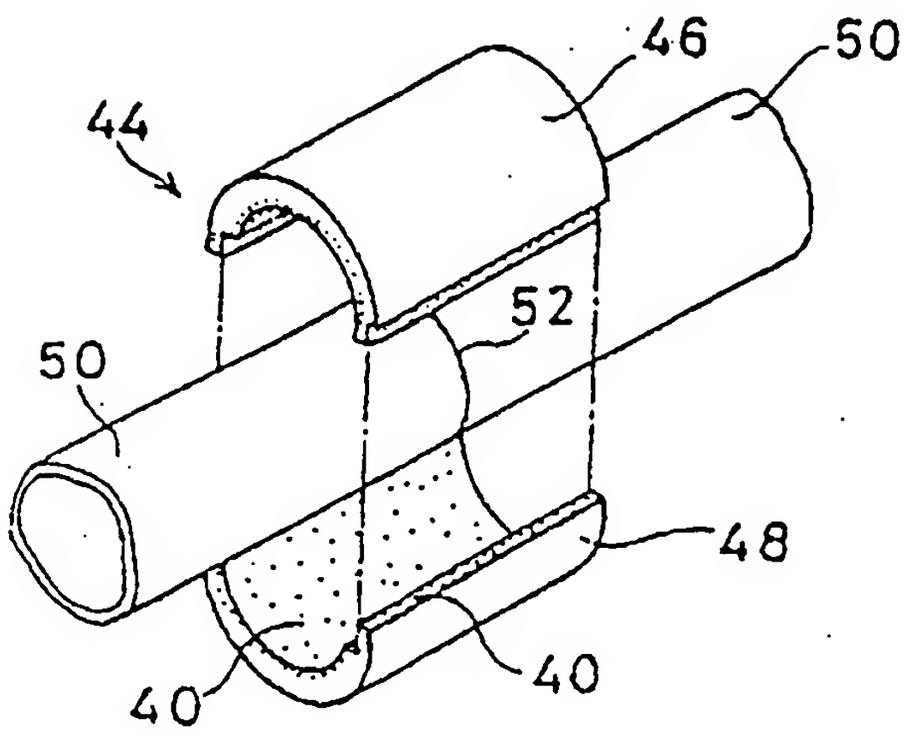


FIG. 13A

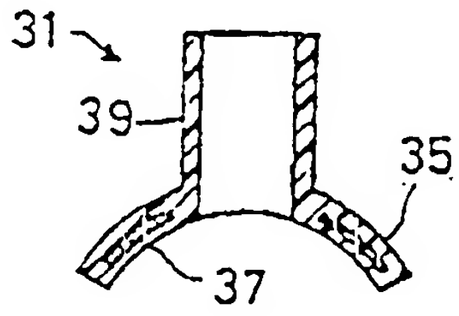


FIG. 13B

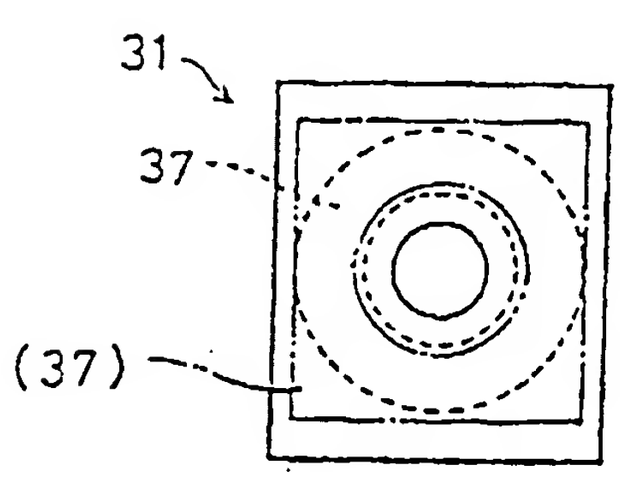


FIG. 14

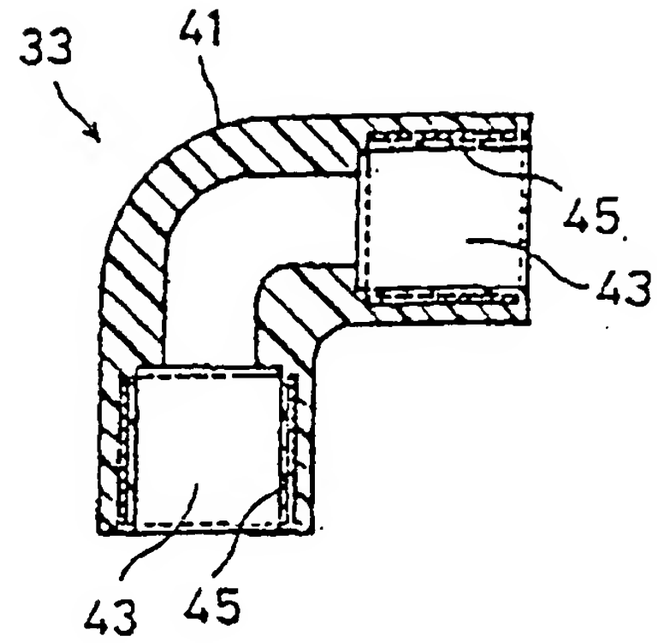
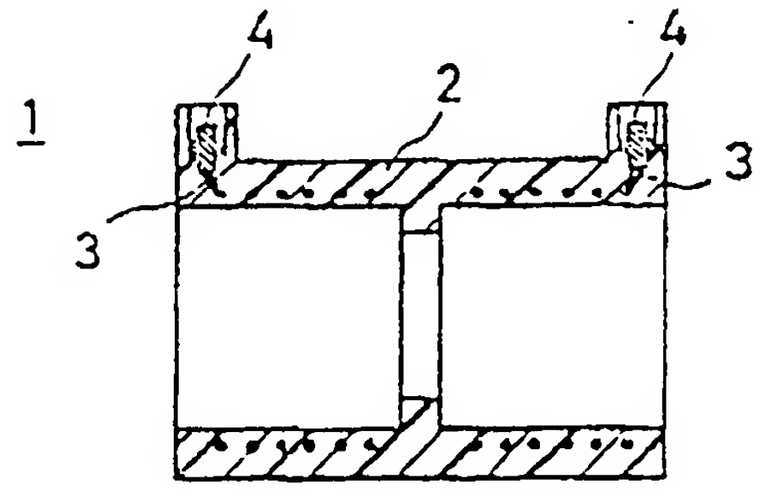


FIG. 15



INTERNATIONAL SEARCH REPORT

International Application No PCT/JP91/00412

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl[5] F16L47/02, B29C65/36

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC	F16L47/00-47/06, B29C65/00-65/36

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

Jitsuyo Shinan Koho 1926 - 1991
Kokai Jitsuyo Shinan Koho 1971 - 1991

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
Y	JP, A, 63-272535 (Nippondenso Co., Ltd.), November 10, 1988 (10. 11. 88), (Family: none)	1-12
Y	JP, A, 61-109996 (Dainichi-Nippon Cables, Ltd.), May 28, 1986 (28. 05. 86), (Family: none)	1-12
Y	JP, A, 62-50122 (Keisuke Isono), March 4, 1987 (04. 03. 87), (Family: none)	1-12
Y	JP, A, 54-58777 (Meisei Kagaku Kogyo K.K.), May 11, 1979 (11. 05. 79), (Family: none)	1-12

[10] Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
June 4, 1991 (04. 06. 91)	June 17, 1991 (17. 06. 91)
International Searching Authority	**Signature of Authorized Officer**
Japanese Patent Office	